ELEC 301 - Introduction to Signals and Systems - Fall 2014

This course introduces the notion of signal processing, and deals with signals, systems, and transforms, from their theoretical mathematical foundations to practical implementation in circuits, computer software and hardware. ELEC 301 acts as a bridge between the introductory ELEC 241/2 and more advanced courses such as ELEC 302, 303, 430, 431, 437, 439.

Instructor:

Richard Baraniuk (http://www.dsp.rice.edu/~richb)
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Teaching Assistant:

Vivek Boominathan (http://www.ece.rice.edu/~vb10/)
Abercrombie A126, vivekb@rice.edu

Location: Duncan Hall Room 1070

Time: Tuesdays/Thursdays 1:00 to 2:15pm

Prerequisites: ELEC 241: Fundamentals of Electrical Engineering I (http://www.owlnet.rice.edu/%7Eelec241/) , ELEC 242: Fundamentals of Electrical Engineering II (http://www.owlnet.rice.edu/%7Eelec242/) , CAAM 335: Matrix Analysis (http://www.caam.rice.edu/%7Ecaam335/) , ELEC 303: Random Signals (co-requisite) (http://www.ece.rice.edu/~fk1/classes/ELEC303.htm)

Required text: Connexions textbook "Signals and Systems", available for free here: http://cnx.rice.edu/content/col10064

Additional Information:

- Course email: elec301TA@gmail.com (mailto:elec301TA@gmail.com) Use this email to contact the course staff with questions, etc. Better than

individual emails.
- Office hours: Vivek Boominathan (TBD), Richard Baraniuk (Wed. 4-5pm, DH 2028)
- Weekly help session: Thursday 7-9pm (DH 1070)
- Information for Group Projects (http://dsp.rice.edu/courses/elec301/projectinfo)
- Information on Printing Posters (http://www.owlnet.rice.edu/~cainproj/printposters.html)
- Current and Past Group Projects (http://dsp.rice.edu/courses/elec301/projects)
- Demos and Applets (http://dsp.rice.edu/courses/elec301/interactive_examples)
- Information on Learning Styles (http://www4.ncsu.edu/unity/lockers/users/f/felder/public/Learning_Styles.html)
- Current and Former Students (http://dsp.rice.edu/courses/elec301/students)
- Connexions (http://cnx.rice.edu)
- "Signal Processing: A view of the future" Part 1 (http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=4806212) , Part 2 (http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=4815546) (accessible from Rice campus network)

Syllabus (http://dsp.rice.edu/courses/elec301/syllabus)

Rice University, MS-380 - 6100 Main St - Houston, TX 77005 - USA - webmaster-dsp@ece.rice.edu (mailto:webmaster-dsp@ece.rice.edu)

ELEC 301 Fall 2014 Syllabus

ELEC 301 - Signals and Systems
Syllabus 2014

Overview

This course deals with *signals, systems, and transforms*, from their theoretical mathematical foundations to practical implementation in circuits and computer algorithms. Fundamentally important, ELEC 301 acts as a bridge between the introductory ELEC 241/2 and more advanced courses such as ELEC 302, 303, 430, 431, 437, 439, ...

Goals

At the conclusion of ELEC 301, you should have a solid understanding of the mathematics of

- signals in continuous and discrete time
- linear time invariant systems and convolution
- Fourier transforms

and how these tools are used in real applications.

Prerequisites

ELEC 241 Fundamentals of Electrical Engineering I (Connexions textbook (http://cnx.rice.edu/content/col10040/latest/))

ELEC 242 Fundamentals of Electrical Engineering II (home page (http://www.owlnet.rice.edu/%7Eelec242/))

CAAM 335 Matrix Analysis (Connexions course (http://cnx.rice.edu/content/col10048/latest/))

MATH 211 Ordinary Differential Equations and Linear Algebra (optional)

Textbook

Elec 301 textbook on Connexions (http://cnx.rice.edu/content/col10064/latest/)

Recommended Further Reading (these and more books on two-hour reserve in the library)

L. Scharf, *A First Course in Electrical and Computer Engineering (http://cnx.org/content/col10685)* in Connexions

G. Strang, *Introduction to Linear Algebra,* Wellesley-Cambridge Press

Z. Karu, *Signals and Systems Made Ridiculously Simple*, ZiZi Press, zizipress.com

M. J. Roberts, *Signals and Systems,* McGraw-Hill

A. Oppenheim and A. Willsky, *Signals and Systems,* Prentice-Hall

S. Haykin and B. Van Veen, *Signals and Systems,* Wiley

B. P. Lathi, *Signal Processing and Linear Systems,* Berkeley Cambridge Press

Who Is Fourier? A Mathematical Adventure, Transnational College of LEX, ISBN 0964350408

And for the ambitious and mathematically inclined, the first five chapters of:

N. Young, *An Introduction to Hilbert Space,* Cambridge Mathematical Textbooks, 1988

Grading

25% - Midterm Exam

25% - Final Exam

25% - Homework

15% - Group Project

10% - Participation

ALL assignments must be completed, or you will receive an incomplete for the course.

Homework Policy

Homework will be posted each week on edX (usually Friday), and is due by 3pm the following Friday. Each assignment will consist of a combination of three types of problems: (i) multiple choice problems in edX, (ii) handwritten free response problems, and (iii) MATLAB problems in edX.

Students will complete and submit the online portion of their assignment at: https://studio.edge.edx.org/Rice/ELEC301ct/course/ELEC301_CT
Any additional paper-based responses must be submitted to Raj Patel in DH 2120 by the due date.

After the due date, 0% credit will be issued. However, all assignments must be turned in, or an incomplete grade will be assigned. Homework, tests, and solutions from previous offerings of this course are *off limits,* under the honor code.

Study Groups

Students may discuss and work on the homework assignment together; however, students must always submit their own work. Of course, group work should not substitute for study on your own; at test time, only a pencil will accompany you...

Testing Policy

Unless otherwise noted on the test instructions, all tests are timed, closed notes/books, and must be taken on your own (i.e., no collaboration with anyone else). Homework, tests, and solutions from previous offerings of this course are *off limits,* under the honor code.

Honor Code

Homework, tests, and solutions from previous offerings of this course are off limits, under the honor code.

Group Project

Towards the end of the semester, students will form groups of 3-4 members and complete a project applying the concepts they have learned in the class. Groups will write a project report in *Connexions* (http://cnx.rice.edu/) and present their projects in a poster session (think "science fair") open to the public. More info on the project (http://dsp.rice.edu/courses/elec301/projectinfo)

(http://dsp.rice.edu/courses/elec301/projectinfo) **Suggestions**

Remember the big picture.
Read the Connexions notes and explore the connections.
Learn linear algebra.

Prepare your own summaries from texts and notes.

Work in groups for homework and studying, and explain the main concepts to each other.

Know and cater to your learning style (http://www2.ncsu.edu/unity/lockers/users/f/felder/public/Learning_Styles.html) .

This course is not about solving specific problems but about developing a problem solving *process* that you can apply to general problems.

Students with disabilities

Any student with a documented disability needing academic adjustments or accommodations is requested to speak with me during the first two weeks of class. All discussions will remain confidential. Students with disabilities should also contact Disabled Student Services in the Ley Student Center.

Course Topics

Introduction

Motivation: Why signal processing is important

Mathematical preliminaries

Discrete-time Signals

Types of signals

Elementary signals

Time-Domain Analysis of Discrete-Time Systems

Types of systems

Linear time invariant (LTI) systems

Convolution

Discrete Fourier Transform (DFT)

DFT, convolution, and LTI systems

Convergence

Fast Fourier Transform (FFT)

Discrete-Time Fourier Transform (DTFT)

DTFT derivation

DTFT properties

- DTFT, convolution, and LTI systems
- Convergence

z-Transform

- Region of convergence
- Implementing discrete-time systems

Discrete-Time Filter Design

- Filter design problem
- Remez exchange algortithm

Time-Domain Analysis of Continuous-Time Systems

- Types of systems
- Linear time invariant (LTI) systems
- Convolution

Continuous-Time Fourier Series (CTFS)

- CTFS derivation
- CTFS properties
- Convergence

Continuous-Time Fourier Transform (CTFT)

- CTFT derivation
- CTFT properties
- CTFT, convolution, and LTI systems
- Convergence

Sampling and Reconstruction

- Sampling and the Nyquist theorem
- Sinc interpolation
- Practical reconstruction

Laplace Transform

- Region of convergence
- Implementing continuous-time systems

Analog Filter Design

- Types of Analog Filters

Analog Filter Design Criteria

Back to **Elec 301 homepage** (http://www.dsp.rice.edu/courses/elec301)

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